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EXAMINER	
BERNATZ, KEVIN M	
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/033,669	Applicant(s) FUJIKATA ET AL.	
	Examiner Kevin M Bernatz	Art Unit 1773	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-29 is/are pending in the application.

4a) Of the above claim(s) 17-22 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-16 and 24-29 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) 1-29 are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 3.
4) ☒ Interview Summary (PTO-413) Paper No(s). 7.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Election/Restrictions

1. Applicants' election of Group I, claims 1 – 16 and 23 - 29 in Paper No. 6 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Examiner's Comments

2. Claims 1, 3, 5 and 6 use the language "in accordance", which appears to be a mistaken use of the word (**ac-cor-dance** *n* **1** : Agreement, Conformity (in ~ with a rule) **2** : the act of granting: Webster's Collegiate Dictionary, 10th Ed.). It appears that applicants intend to claim that the films are "adjacent" or "directly deposited" on one another, and the Examiner recommends switching to such language (or its equivalents) to better clarify the claims.

3. Claim 1 recites the limitation "average surface height unevenness", which has been interpreted to simply mean the "average surface roughness", i.e. "Ra". See claims 2 – 6.

Specification

4. The disclosure is objected to because of the following informalities: "oC" in the specification and abstract should be "°C". In addition, "10^{-9} torr" should be all on one line in the abstract for clarity.

Claim Objections

5. Claim 16 is objected to because of the following informalities: "according to claim 1, claim 2" should be clarified to either be just claim 1 or 2, or "according to claim 1 or 2". Appropriate correction is required. For purposes of evaluating the prior art, claim 16 was deemed to depend on either claim 1 or claim 2. In addition, "layer" should be inserted after "NiFeCo".

6. Claim 23 is objected to because of the following informalities: applicants should consider rewording "formed in the process according to claim 1" to just "according to claim 1" since claim 1 is a product claim and not a process claim.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. Claims 1 – 7, 9 – 16 and 23 are rejected under 35 U.S.C. 102(a) as being anticipated by Fujikata et al. (J. App. Phys., 89(11), 2001, 7558 - 7560) ***as evidenced by Portier et al. (App. Phys. Let., 79(1), 2001, 57 – 59)***.

Regarding claims 1, 3, 5 and 6, a comparison between the claimed and prior art structure is best illustrated by the following table:

Claim 1	Fujikata: bottom AF	Claim 3	Claim 5	Fujikata: top AF	Claim 6
Upper electrode	Ta	Upper electrode	Upper electrode	Ta	Upper electrode
2nd magnetic	NiFe	2nd magnetic	Antiferromagnetic	PtMn	Antiferromagnetic
Tunnel barrier	AlOx	Tunnel barrier	--	CoFe	3rd magnetic
1st magnetic	(CoFe/NiFe)	1st magnetic	--	Ru	Non-magnetic
--	CoFe	4th magnetic	--	CoFe	4th magnetic
--	Ru	Non-magnetic	1st magnetic	(CoFe/NiFe)	1st magnetic
--	CoFe	3rd magnetic	Tunnel barrier	AlOx	Tunnel barrier
Antiferromagnetic	PtMn	Antiferromagnetic	2nd magnetic	(NiFe/CoFe)	2nd magnetic
Under layer	Ta	Under layer	Under layer	Ta	Under layer
Lower electrode	(Cu,Au,Pt)/CoZrTa	Lower electrode	Lower electrode	(Cu,Au,Pt)/CoZrTa	Lower electrode
substrate	substrate	substrate	substrate	Substrate	Substrate

As can be seen above, Fujikata et al. disclose structures meeting applicants' claimed limitations for the embodiments in claims 1, 3, 5 and 6. Fujikata et al. further teach underlayer materials meeting applicants' claimed limitation, e.g. "Ta", and also teach that the surface roughness of the underlayer is smoothed (*Experimental section and Figure 2*).

It has been held that where claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a *prima facie* case of either anticipation or obviousness has been established and the burden of proof is shifted to applicant to show that prior art products do not necessarily or inherently possess characteristics of claimed products where the rejection is based on inherency under 35 USC 102 or on *prima facie* obviousness under 35 USC 103, jointly or alternatively. Therefore, the *prime facie* case can be rebutted by ***evidence*** showing that the prior art products do not necessarily possess the characteristics of the claimed product. *In re Best*, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977). "When the PTO shows a sound basis for believing that the products of the applicant and the prior art are the same, the applicant has the burden of showing that they are not." *In re Spada*, 911 F.2d 705, 709, 15 USPQ2d 1655, 1658 (Fed. Cir. 1990).

In the instant case, the Examiner's sound basis for the belief of inherency is that the claimed and prior art products are identical in structure and composition, as shown in the table above, and are produced by a substantially identical process: controlling the surface roughness of the underlayer by introducing oxygen. Furthermore, it is noted that the exchange coupling force between the first magnetic film and the antiferromagnetic film is effected by the surface bonding between the two layers: improved bonding leads to increased exchange coupling, ***as evidenced by Portier et al. (page 59, underlined sections)***. Finally, the Examiner notes that it is known in the art that two magnetic layers separated by a non-magnetic Ru layer < ~1.1 nm in

thickness are inherently coupled in an antiferromagnetic/anti-parallel manner. Fujikata et al. disclose using a 0.7 nm Ru layer (*Results and Discussion: section A.1.*).

Therefore, in addition to the above disclosed limitations, the presently claimed properties of "Hr and Hc2 satisfy the relationship of Hc2 <Hr" (claims 1, 3, 5 and 6), "the average surface [roughness] of said antiferromagnetic thin film on said underlayer being in the range of 0.1 to 5 Angstroms" (claims 1, 3, 5 and 6), and "wherein said third magnetic thin film and said fourth magnetic thin film are antiferromagnetically coupled via said non-magnetic thin film" (claims 3 and 6) would have inherently been present because the claimed and prior art products are identical in structure and composition, and are produced by a substantially identical process.

Regarding claims 2 and 4, it is known in the art that subsequently deposited layers are effected by the surface roughness of the layers below them, and that in TMR devices, the critical layer is the tunnel barrier layer. Therefore, given that the claimed and prior art products are identical in structure and composition and produced by substantially identical processes, the Examiner deems there is sound basis for the belief that the claimed limitation "the average surface roughness of said first magnetic thin film is in the range from 0.1 to 5 Angstroms" would have inherently been present for the reasons cited above.

Regarding claims 7, 9 – 11, 14 and 15, Fujikata et al. disclose materials and thickness values meeting applicants' claimed limitations for the AFM layer (*PtMn*), tunnel barrier layer (*5 – 7.5 Å AlOx*), magnetic layers (*NiFe and FeCo*) and non-magnetic layer (*7 Å Ru*).

Regarding claims 12 and 13, Fujikata et al. disclose electrodes comprising a dual layer, including a CoZrTa layer. The Examiner deems that the prior art product would inherently possess an amorphous structure for the reasons above, and also for the reason that it is a CoZr alloy, which is known in the art to form amorphous alloys, and is used for an identical purpose as applicants (part of the bottom lead/electrode for a TMR element).

Regarding claim 16, Fujikata et al. disclose interface films meeting applicants' claimed composition and thickness limitations (*CoFe, NiFe and Figure 3*).

Regarding claim 23, Fujikata et al. disclose elements having a square shape with sizes down to 0.3 μm per side, as well as resistance values meeting applicants' claimed range limitation (*page 7560 – "with a resistance of 65.2 Ω"*).

9. Claims 1, 2, 5, 7 – 11 are rejected under 35 U.S.C. 102(e) as being anticipated by Araki et al. (U.S. Patent No. 6,335,081 B1) ***as evidenced by Portier et al. (App. Phys. Let., 79(1), 2001, 57 – 59)***.

Regarding claims 1, 3, 5 and 6, a comparison between the claimed and prior art structure is best illustrated by the following table:

Claim 1	Araki: bottom AF	Claim 5	Araki: top AF
Upper electrode	Layer 75	Upper electrode	Layer 95
2nd magnetic	Layer 20	Antiferromagnetic	Layer 50
Tunnel barrier	Layer 30	1st magnetic	Layer 40
1st magnetic	Layer 40	Tunnel barrier	Layer 30
Antiferromagnetic	Layer 50	2nd magnetic	Layer 20
Under layer	Layer 8	Under layer	Layer 8
Lower electrode	Layer 71	Lower electrode	Layers 101/91
substrate	substrate	substrate	Substrate

The Examiner notes that the Araki et al. structures are disclosed in Figures 1 and 2, as well as col. 6, lines 47 – 56.

As can be seen above, Araki et al. disclose structures meeting applicants' claimed limitations for the embodiments in claims 1 and 5. Araki et al. further teach underlayer materials meeting applicants' claimed limitation, e.g. "Ta", and also teach that the surface roughness of the underlayer is smoothed to 5 Å or less (*col. 2, lines 28 – 43 and 58 – 59 and Examples*).

In the instant case, the claimed and prior art products are substantially identical in structure and composition, as shown in the table above. Furthermore, it is noted that the exchange coupling force between the first magnetic film and the antiferromagnetic film is effected by the surface bonding between the two layers: improved bonding leads to increased exchange coupling, ***as evidenc d by Portier et al. (pag 59, und rlined sections)***.

Therefore, in addition to the above disclosed limitations, the presently claimed properties of "Hr and Hc2 satisfy the relationship of Hc2 <Hr" (claims 1 and 5) would have inherently been present because the Examiner has sound basis for believing the properties are inherent, namely that the claimed and prior art products are substantially identical in structure and composition.

Regarding claim 2, it is known in the art that subsequently deposited layers are effected by the surface roughness of the layers below them, and that in TMR devices, the critical layer is the tunnel barrier layer (*Araki et al., col. 2, lines 10 – 12*). Therefore, given that the claimed and prior art products are substantially identical in structure and composition, the Examiner deems there is sound basis for the belief that the claimed limitation "the average surface roughness of said first magnetic thin film is in the range from 0.1 to 5 Angstroms" would have inherently been present for the reasons cited above.

Regarding claims 7 – 11, Araki et al. disclose materials and thickness values meeting applicants' claimed limitations for the AFM layer (*PtMn – example 1*), underlayer (*100 Å Ta – col. 5, lines 56 – 61 and example 1*), tunnel barrier layer (*5 – 20 Å AlOx – col. 6, lines 28 - 35*) and magnetic layers (*NiFe and FeCo – col. 5, line 66 bridging col. 6, line 16 and Example 1*).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. Claims 3, 4, 6 and 14 – 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. as applied above, and further in view of Gill (U.S. Patent No. 6,127,045) and Park et al. (IEEE. Trans. Mag., 35(5), 1999, 2919 – 2921).

Regarding claims 3, 4 and 6, Araki et al. is relied upon as described above. Araki et al. further disclose replacing the free or pinned layer with a synthetic layer in antiferromagnetic coupling: magnetic/ non-magnetic / magnetic (*col. 6, lines 17 – 27*).

Araki et al. fail to disclose a structure meeting applicants' claimed limitations, specifically embodiments comprising a synthetic "pinned layer" and an additional magnetic layer adjacent to the tunnel barrier layer, i.e. "3rd magnetic/non magnetic/4th magnetic/1st magnetic".

Claim 3	Araki: bottom AF	Claim 6	Araki: top AF
Upper electrode	Layer 75	Upper electrode	Layer 95
2nd magnetic	Layer 20	Antiferromagnetic	Layer 50
Tunnel barrier	Layer 30	3rd magnetic	CoFe
1st magnetic	--	Non magnetic	Ru
4th magnetic	CoFe	4th magnetic	CoFe
Non magnetic	Ru	1st magnetic	--
3rd magnetic	CoFe	Tunnel barrier	Layer 30
Antiferromagnetic	Layer 50	2nd magnetic	Layer 20
Under layer	Layer 8	Under layer	Layer 8
Lower electrode	Layer 71	Lower electrode	Layers 101/91
substrate	substrate	substrate	Substrate

However, Park et al. teach that it is known in the art to use interface layers between the free and pinned layers inorder to improve the MR ratio (*Abstract, page 2919 – underlined sections*) and Gill teaches that these interface layers can also be used adjacent to synthetic antiferromagnetically coupled layers (*col. 5, lines 46 – 54*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. to insert a "first magnetic" interface layer between the synthetic "third magnetic" / "non-magnetic" / "fourth magnetic" pinned layers disclosed by Araki et al., since Park et al. and Gill teach that such an interface layer results in an improved MR ratio.

Regarding claims 14 and 16, Araki et al. disclose ferromagnetic materials (*FeCo – col. 6, lines 23 – 25*) and non-magnetic materials + thickness values (*7 Å Ru - col. 6,*

lines 23 - 25) meeting applicants' claimed limitations for the synthetic pinned layer structure.

Regarding claim 16, both Park et al. and Gill disclose interface materials and thickness values meeting applicants' claimed composition and thickness limitations (*Gill: col. 6, lines 49 – 50 and 56 – 58; Park et al.: Figure 1*).

12. Claims 2 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. as applied above, and further in view of Araki et al. (U.S. Patent No. 6,483,675 B1).

Araki et al. ('081) is relied upon as described above.

Even in the event that the first magnetic film does not necessarily possess a surface roughness meeting applicants' claimed limitation of less than 5 Å, Araki et al. ('675) teach that it is important to control the surface roughness of the tunnel barrier layer by controlling the surface roughness of "the layers which have been formed before forming the tunnel barrier layer" (*col. 3, lines 5 – 7 and col. 6, lines 22 - 29*) to surface roughness values meeting applicants' claimed range (*col. 2, lines 26 – 39*). Araki et al. ('675) further teach that a smooth tunnel barrier layer possess good MR ratio and no pin-holes (*col. 1, line 47 bridging col. 2, line 11*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. ('081) to possess a first magnetic layer meeting applicants' claimed surface roughness limitation as taught by Araki et al. ('675), since it is known that controlling the surface roughness of the layers

formed before the tunnel barrier layer will allow for the formation of a smooth tunnel barrier layer possessing good MR ratio and no pin-holes.

13. Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. as applied above, and further in view of Suzuki (JP 10-162320 A) and Hayashi (U.S. Patent No. 5,849,422). See U.S. Patent No. 6,084,405 which is the U.S. equivalent of JP '320 A.

Regarding claims 12 and 13, Araki et al. is relied upon as described above. Araki et al. further disclose a lower electrode layer comprising a magnetic material having a shield effect (*Figure 2, layer 91 –"common lead and shield layer **91** (NiFe", example 1*) and a non-magnetic material (*layer 101 – "Rh"*).

Araki et al. fail to disclose using an amorphous CoZr alloy as the magnetic material of layer 91.

However, Suzuki teaches that amorphous CoZr alloy magnetic materials are equivalent magnetic materials for the soft magnetic layer provided between the antiferromagnetic layer and the substrate (*Figure 7, layers 4, 24 and 6; col. 8, line 45 bridging col. 9, line 1; and col. 12, lines 16 - 17*) and Hayashi et al. teach that the choice of an amorphous CoZr alloy is preferred because "good magnetic characteristics can be obtained even in the case where special attention is not paid to the back pressure during the film formation and target purity as compared to the case where NiFe and others are used" (*col. 3, lines 43 – 55*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. to include an amorphous CoZr alloy as layer 91 as taught by Suzuki and Hayashi, since "good magnetic characteristics can be obtained even in the case where special attention is not paid to the back pressure during the film formation and target purity as compared to the case where NiFe and others are used".

14. Claims 23 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. as applied above, and further in view of Redon et al. (U.S. Patent No. 6,519,124 B1) and Sun et al. (U.S. Patent App. No. 2002/0097534 A1).

Regarding claim 23, Araki et al. is relied upon as described above. Araki et al. further disclose forming the elements into square shapes meeting applicants' claimed size limitations (*"the size of the TMR element actually used is about (0.15 μm x 0.15 μm) to (1 μm x 1 μm)" – col. 10, lines 15 – 16*).

Araki et al. fail to disclose the resistance of the element.

However, Araki et al. teach that it is known in the art that the resistance is desired to be low, but that the lower the resistance, the harder it is to form the tunnel barrier layer (*col. 1, line 45 bridging col. 2, line 9*). Redon et al. also teach that there is "a trade-off between high TMR ratio and MTJ resistance" (*col. 2, line 66 bridging col. 3, line 21*), with typical resistance values ranging from 15 Ω and up, though it is the 'resistance x area' product, RA, which is most critical (*col. 2, lines 13 – 21*). Finally, Sun

et al. provides data indicating ranges in resistance obtainable for various tunnel barrier layer thickness values (*Figure 5A and 5B*).

Therefore, Araki et al., Redon et al. and Sun et al. all teach the importance of optimizing the resistance for improved MR ratio and no pin-holes. The Examiner deems that it would have been obvious to one having ordinary skill in the art to have determined the optimum value of a cause effective variable such as the resistance of the MR element through routine experimentation, especially given the teachings in the art cited above regarding the desire to optimize the resistance to produce a MR element with a good MR ratio, good RA product, and without any pin-hole effects. *In re Boesch*, 205 USPQ 215 (CCPA 1980); *In re Geisler*, 116 F. 3d 1465, 43 USPQ2d 1362, 1365 (Fed. Cir. 1997); *In re Aller*, 220 F.2d, 454, 456, 105 USPQ 233, 235 (CCPA 1955).

Regarding claim 26, Araki et al. disclose a shielded-type MR sensor comprising soft magnetic material having shielding effect which sandwiches on top and bottom the claimed MR element (*Figures 2 and 3 – layers 91 and 95 and col. 7, lines 44 – 65*).

15. Claims 24 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. in view of Redon et al. and Sun et al. as applied above, and further in view of Suzuki (JP '320 A). See U.S. Patent No. 6,084,405 which is the U.S. equivalent of JP '320 A.

Araki et al. is relied upon as described above. Araki et al. further disclose supplying a bias means adjacent to said "second" magnetic thin film, i.e. the "free" layer (*col. 8, lines 8 – 20*).

Araki et al. fail to disclose whether the "second" magnetic thin film is in a single domain state.

However, Suzuki teaches that it is known in the art to apply the bias to keep the adjacent ferromagnetic layer in the single domain state (*col. 9, line 65 bridging col. 10, line 6*) and that such a bias can shift the resistance curve and widen the dynamic range (*col. 10, lines 39 – 46*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. to use a bias means to hold the free magnetic layer into a single domain state as taught by Suzuki, since such a bias means results in a wider dynamic range for the MR element.

Regarding claim 25, Suzuki et al. disclose that an antiferromagnetic layer is a preferred means for applying the bias (*col. 9, lines 64 – 67*).

16. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. in view of Redon et al. and Sun et al. as applied above, and further in view of Coehoorn et al. (IEEE Trans. Mag., 35(5), 1999, 2586 – 2588).

Araki et al. is relied upon as described above.

Araki et al. fail to disclose using the MR element in a yoke-type sensor.

However, Coehoorn et al. teach that yoke-type magnetic sensors comprising TMR elements and soft-magnetic films are known in the art to possess intrinsically lower noise than shield-type magnetic heads (*Introduction and Figures*).

The limitations "in which a signal field is guided to a spin tunnel magnetoresistive effect element" and "having shield effect" are functional limitation(s). As defined in the MPEP, "[a] functional limitation is an attempt to define something by what it does, rather than by what it is (e.g., as evidenced by its specific structure or specific ingredients). There is nothing inherently wrong with defining some part of an invention in functional terms. Functional language does not, in and of itself, render a claim improper. *In re Swinehart*, 439 F.2d 210, 169 USPQ 226 (CCPA 1971)" – MPEP § 2173.05(g). However, the examiner notes that "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an ***inherent characteristic of the prior art***, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on" (emphasis added) - MPEP § 2183.

In the instant case, the claimed limitation(s) are deemed to necessarily result from the disclosed "yoke-type" MR head structure since the claimed and prior art yoke-type heads are substantially identical in composition and/or structure. The examiner's sound basis for this assertion is that Coehoorn et al. disclose yoke-type heads using tunnel MR elements (*Figure 1*), wherein the flux guides are soft magnetic materials (*Figure 2*) and soft magnetic materials are known in the art to be used as shield layers in shield-type magnetic heads (*example 1*).

17. Claims 28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Araki et al. in view of Redon et al. and Sun et al. as applied above, and further in view of Gill ('045).

Araki et al. is relied upon as described above.

Araki et al. fail to disclose the apparatus limitations in claims 28 and 29.

However, Gill teaches that MR sensors comprising spin tunnel MR effect elements (*Figure 3, element 321 and col. 4, lines 57 - 60*) necessarily possess "means for detecting a resistance change ratio of said spin valve tunnel magnetoresistive effect element as a function of a detected magnetic field" (claim 28) (*col. 2, lines 5 – 37*), a "magnetic recording medium onto which information is recorded" (claim 29) (*Figure 3, element 312 and col. 4, lines 50 - 56*), a MR sensor which "plays back information recorded on said magnetic recording medium" (claim 29) (*col. 4, line 45 bridging col. 5, line 28*), and "an actuator for the purpose of controlling movement of said magnetoresistive sensor to a selected position on said magnetic recording medium" (claim 29) (*Figure 3, element 327 and col. 4, lines 63 - 67*), since the above are limitations required for the magnetic apparatus to function as a magnetic head capable of reading and writing to magnetic recording media.

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Araki et al. in view of Redon et al. and Sun et al. to meet applicants' claimed structural limitations as taught by Gill inorder to produce a magnetic head capable of reading and writing to magnetic recording media.

18. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. as applied above, and further in view of Araki et al. ('675).

Fujikata et al. is relied upon as described above.

Fujikata et al. fail to disclose the thickness of the underlayer.

However, Araki et al. disclose TMR elements possessing a similar structure to Fujikata et al. (*Figure 2*) wherein the underlayer (*layer 8*) is controlled to thickness values meeting applicants' claimed thickness limitations (*col. 6, lines 44 – 47 – "20 Å to 100 Å"*) so that the underlayer can be smoothed to provide a smooth tunnel barrier layer free of pinholes (*col. 2, lines 3 – 11 and lines 27 – 59 and col. 3, lines 8 – 10*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Fujikata et al. to include an underlayer meeting applicants' claimed thickness limitations as taught by Araki et al. inorder to produce a smoothed underlayer, and hence a smooth tunnel barrier layer free of pinholes.

19. Claims 24 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. as applied above, and further in view of Suzuki (JP '320 A). See U.S. Patent No. 6,084,405 which is the U.S. equivalent of JP '320 A.

Fujikata et al. is relied upon as described above.

Fujikata et al. fail to disclose applying bias means such that the "second" magnetic thin film is in a single domain state.

However, Suzuki teaches that it is known in the art to apply the bias to keep the adjacent ferromagnetic layer in the single domain state (*col. 9, line 65 bridging col. 10, line 6*) and that such a bias can shift the resistance curve and widen the dynamic range (*col. 10, lines 39 – 46*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Fujikata et al. to use a bias means to hold the free magnetic layer into a single domain state as taught by Suzuki, since such a bias means results in a wider dynamic range for the MR element.

Regarding claim 25, Suzuki et al. disclose that an antiferromagnetic layer is a preferred means for applying the bias (*col. 9, lines 64 – 67*).

20. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. as applied above, and further in view of Araki et al. ('081).

Fujikata et al. is relied upon as described above.

Fujikata et al. fail to disclose a shielded-type MR sensor meeting applicants' claimed structural limitations.

However, Araki et al. disclose a shielded-type MR sensor comprising soft magnetic material having shielding effect which sandwiches on top and bottom the claimed MR element (*Figures 2 and 3 – layers 91 and 95 and col. 7, lines 44 – 65*) as known in the art for typical TMR elements for use in magnetic heads to read small magnetic field changes (*col. 1, liens 6 – 15*).

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Fujikata et al. to meet applicants' claimed structural limitations as taught by Araki et al., since such a structure is known in the art for typical TMR elements for use in magnetic heads to read small magnetic field changes.

21. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. as applied above, and further in view of Coehoorn et al. (IEEE Trans. Mag., 35(5), 1999, 2586 – 2588).

Fujikata et al. is relied upon as described above.

Fujikata et al. fail to disclose using the MR element in a yoke-type sensor.

However, Coehoorn et al. teach that yoke-type magnetic sensors comprising TMR elements and soft-magnetic films are known in the art to possess intrinsically lower noise than shield-type magnetic heads (*Introduction and Figures*).

The limitations "in which a signal field is guided to a spin tunnel magnetoresistive effect element" and "having shield effect" are functional limitation(s).

In the instant case, the claimed limitation(s) are deemed to necessarily result from the disclosed "yoke-type" MR head structure since the claimed and prior art yoke-type heads are substantially identical in composition and/or structure. The examiner's sound basis for this assertion is that Coehoorn et al. disclose yoke-type heads using tunnel MR elements (*Figure 1*), wherein the flux guides are soft magnetic materials

(*Figure 2*) and soft magnetic materials are known in the art to be used as shield layers in shield-type magnetic heads (*example 1*).

22. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. as applied above, and further in view of Gill ('045).

Fujikata et al. is relied upon as described above.

Fujikata et al. fail to disclose applicants' claimed apparatus limitations.

However, Gill teaches that MR sensors comprising spin tunnel MR effect elements (*Figure 3, element 321 and col. 4, lines 57 - 60*) necessarily possess "means for detecting a resistance change ratio of said spin valve tunnel magnetoresistive effect element as a function of a detected magnetic field" (claim 28) (*col. 2, lines 5 – 37*), a "magnetic recording medium onto which information is recorded" (claim 29) (*Figure 3, element 312 and col. 4, lines 50 - 56*), a MR sensor which "plays back information recorded on said magnetic recording medium" (claim 29) (*col. 4, line 45 bridging col. 5, line 28*), and "an actuator for the purpose of controlling movement of said magnetoresistive sensor to a selected position on said magnetic recording medium" (claim 29) (*Figure 3, element 327 and col. 4, lines 63 - 67*), since the above are limitations required for the magnetic apparatus to function as a magnetic head capable of reading and writing to magnetic recording media.

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Fujikata et al. to meet applicants'

claimed structural limitations as taught by Gill inorder to produce a magnetic head capable of reading and writing to magnetic recording media.

23. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fujikata et al. in view of Araki et al. ('081) as applied above, and further in view of Gill ('045).

Fujikata et al. in view of Araki et al. is relied upon as described above.

Neither Fujikata et al. nor Araki et al. disclose applicants' claimed apparatus limitations.

However, Gill teaches that MR sensors comprising spin tunnel MR effect elements (*Figure 3, element 321 and col. 4, lines 57 - 60*) necessarily possess "means for detecting a resistance change ratio of said spin valve tunnel magnetoresistive effect element as a function of a detected magnetic field" (claim 28) (*col. 2, lines 5 – 37*), a "magnetic recording medium onto which information is recorded" (claim 29) (*Figure 3, element 312 and col. 4, lines 50 - 56*), a MR sensor which "plays back information recorded on said magnetic recording medium" (claim 29) (*col. 4, line 45 bridging col. 5, line 28*), and "an actuator for the purpose of controlling movement of said magnetoresistive sensor to a selected position on said magnetic recording medium" (claim 29) (*Figure 3, element 327 and col. 4, lines 63 - 67*), since the above are limitations required for the magnetic apparatus to function as a magnetic head capable of reading and writing to magnetic recording media.

It would therefore have been obvious to one of ordinary skill in the art at the time of the applicant's invention to modify the device of Fujikata et al. in view of Araki et al. to

meet applicants' claimed structural limitations as taught by Gill inorder to produce a magnetic head capable of reading and writing to magnetic recording media.

Conclusion

24. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Granstrom (U.S. Patent App. No. 2003/0112564) provides general background teaching the relationships between GMR, AMR and TMR elements and the fact that many elements of the different MR elements are interchangeable (*entire Background section*). Sun et al. (J. App. Phys., 89(11), 2001, 6653 – 6655), Cardoso et al. (J. App. Phys., 89(11), 2001, 6650 – 6652), Sun et al. (App. Phys. Let., 2000, 76(17), 2424 – 2426) and Sin et al. (IEEE Trans. Mag., 2000, 36(5), 2818 – 2820) all describe TMR elements wherein the surface roughness of the layer(s) below the tunnel barrier layer are controlled to be extremely smooth to optimize the MR properties. The Examiner notes that no rejections were made using these references since the above references teach similar subject matter already relied upon in the rejections of record, i.e. the Examiner's burden is to apply the closest prior art to further prosecution. However, applicants' should review the above references since they appear to be similar to the claimed invention.

25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin M Bernatz whose telephone number is (703) 308-1737. The examiner can normally be reached on M-F, 9:00 AM - 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Thibodeau can be reached on (703) 308-2367. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0651.

Kevin M. Bernatz
Patent Examiner

July 8, 2003